



E-ISSN: 2708-0021

P-ISSN: 2708-0013

[www.actajournal.com](http://www.actajournal.com)

AEZ 2020; 1(2): 37-45

Received: 19-05-2020

Accepted: 23-06-2020

**Ahasan Ullah Khan**

a) Department of Entomology,  
Sylhet Agricultural University,  
Sylhet, Bangladesh

b) Climate-Smart Agriculture Lab,  
Department of Agroforestry and,  
Environmental Science, Sylhet  
Agricultural University, Sylhet,  
Bangladesh

**Md. Abdur Razzak Choudhury**

a) Department of Entomology,  
Sylhet Agricultural University,  
Sylhet, Bangladesh

**Mohammad Samiul Ahsan Talucder**

b) Climate-Smart Agriculture Lab,  
Department of Agroforestry and,  
Environmental Science, Sylhet  
Agricultural University, Sylhet,  
Bangladesh

c) Interdisciplinary Research for  
Future Agriculture, Sylhet  
Agricultural University, Sylhet,  
Bangladesh

**Md. Shahadat Hossain**

Department of Soil Science, Sylhet  
Agricultural University, Sylhet,  
Bangladesh

**Shajahan Ali**

Department of Soil Science, Sylhet  
Agricultural University, Sylhet,  
Bangladesh

**Taslima Akter**

Department of Horticulture, Sylhet  
Agricultural University, Sylhet,  
Bangladesh

**Md. Ehsanullah**

Department of Entomology,  
Faculty of Agriculture, Govt.  
shahid Akbar Ali Science and  
Technology College, Thakurgaon,  
Bangladesh

#### Corresponding Author:

**Ahasan Ullah Khan**

a) Department of Entomology,  
Sylhet Agricultural University,  
Sylhet, Bangladesh

b) Climate-Smart Agriculture Lab,  
Department of Agroforestry and,  
Environmental Science, Sylhet  
Agricultural University, Sylhet,  
Bangladesh

## Constraints and solutions of country bean (*Lablab purpureus* L.) Production: A review

**Ahasan Ullah Khan, Md. Abdur Razzak Choudhury, Mohammad Samiul Ahsan Talucder, Md. Shahadat Hossain, Sahjahan Ali, Taslima Akter and Md. Ehsanullah**

**DOI:** <https://doi.org/10.33545/27080013.2020.v1.i2a.17>

### Abstract

At present food-security and sustainability is a burning issue all over the world. Many indigenous food crops of Bangladesh which promises to ameliorate fruit nutritional food demand and they have the good possibility to develop the world market. Country bean is one of the most important vegetables and pulse crop which have tremendous nutritional value and this crop is cultivated round of the year. Insects, diseases, weeds and soil nutrient management were found as the major barriers for country bean production. Lack of technical knowledge and improper crop management approaches were observed to bean cultivation. To optimize the higher yield of country bean, it had to use less hazardous insecticides, fungicides, biocides, herbicides, and balanced fertilizer and bio-fertilizers in crop management practice. This review paper examined the problems and solutions for the country bean production.

**Keywords:** *Lablab purpureus*, insects, diseases, weeds, management

### Introduction

Country bean is an important vegetable-cum-pulse, food-secure and nutritious crop. Bean is a member of Leguminosae, sub-family Papilionaceae. This bean is well known as "Sheem" and the scientific name is *Lablab purpureus*, *Dolichos lablab* or *Dolichos niger*. It is reported to be originated in India (Sibiko *et al.* 2013; Chowdhury *et al.* 1989)<sup>[1, 2]</sup> and then spread to other parts of the world. It is grown in a significant acreage after brinjal and tomato in Bangladesh. Generally, it is also known as income generating crop in our country. It is widely grown in Cumilla, Noakhali, Sylhet, Dhaka, Kishoregonj, Tangail, Jashore, Pabna, Dinajpur, and Cartogram intensively but for the last ten years it has been extended to Khulna and Barisal regions (Singh *et al.* 2019; Aditya, 1993)<sup>[3,4]</sup>. This crop fixes atmospheric nitrogen in a symbiotic relationship with rhizobium bacteria in the soil (Karla, 2009)<sup>[5]</sup>. It plays a big dietary role supplying proteins, carbohydrates, essential elements and vitamins to both rural and urban people. The fresh pods and green seeds are eaten boiled or are used to prepared curries, ripe seeds are also used as pulse, often as soup "dhal" (Sultana, 2001)<sup>[6]</sup> and mature seeds are occasionally sun-dried and stored for use as vegetables. It contains 4.2 g protein, 110 mg calcium, 4.7 mg iron, 2.4 mg vitamin A and 35 mg vitamin C in 100 g edible parts of bean (Anonymous, 2013)<sup>[7]</sup>. Protein percentage of country bean is 4.5% in green pod and 25% in dry seed and has a great demand for both young pods and mature seeds irrespective of rich and poor. It also contains significant amounts of thiamin, riboflavin, niacin, vitamin C, and iron (0.1, 0.06, 0.7, 9.0, and 4.1.7 mg/100 gm); respectively (Rehana, 2006)<sup>[8]</sup>. The green pods and developed unripe seeds serve as delicious protein rich vegetables (Wortman *et al.* 2004)<sup>[9]</sup> and antifungal protein (Ye *et al.* 2000)<sup>[10]</sup>, good source of iron and zinc (Buruchara *et al.* 2011)<sup>[11]</sup> and have a low glycemic index (Widers, 2006)<sup>[12]</sup>. However, its production is hampered due to attack of a number of insects, diseases, weeds (Specially in summer season) and cause severe damage to country bean. In view of above facts, the present study was undertaken to review the information on the effect of insect, diseases, weeds and soil nutrients of the country bean production.

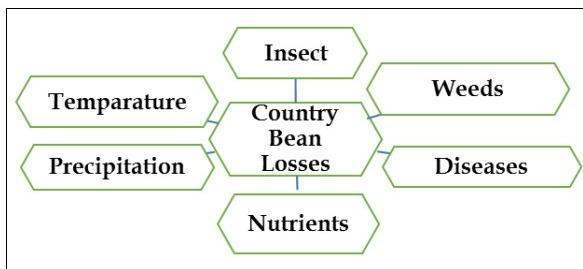
### Methodology

To assess the current state of the research on insects and diseases of country bean, a review of the existing journal literature, books, report, blogs and newspaper were carried out.

**Keywords:** (*Lablab purpureus*, insects, diseases, weeds, management) search in the google, google scholar, research gate ([www.researchgate.net](http://www.researchgate.net)), web of science database ([www.thomsonreuters.com/web-of-science](http://www.thomsonreuters.com/web-of-science)) and a full-text search of the Science Direct ([www.sciencedirect.com](http://www.sciencedirect.com)) database were carried out. Information was also collected from government organization and NGO's by personal communication.

### The Country Bean Yield Loss Topology and Assessment

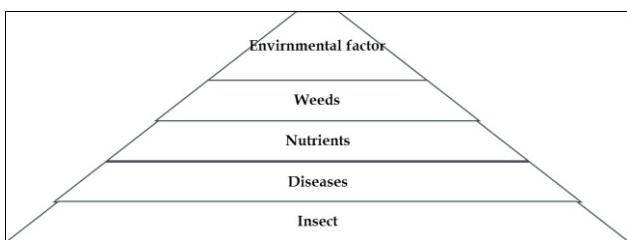
Country bean yield losses may be caused by abiotic and biotic environmental factors, leading to the reduction of crop performance and resulting in a lower actual yield than the site-specific attainable yield/production of crops. The study revealed that the adverse abiotic factors (precipitation, temperature and nutrients) and biotic factors (harmful insect, weeds and diseases) was responsible to reduce the country bean production (Figures 1). The abiotic and biotic factor effects in country bean ecosystem were in decreasing ranked order of yield, diseases (20-100%)> harmful insect (20-45%)> weeds, (15-145%)> soil nutrients (10-20%)> and environmental factors (10-15%); respectively [Figure 2, and Table 1].



**Fig 1:** Abiotic and biotic factors causing country bean yield losses

**Table 1:** Review of literature on the barrier and yield loss (%) rank of country bean production

Items	Yield-loss (%)	References
Insect	20-45	(Singh and Allen, 1980, Ochilo <i>et al.</i> , 2011; Uddin <i>et al.</i> 2014) [13, 14, 15].
Diseases	20-100	(Singh and Schwartz, 2010) [16].
Soil Nutrients	10-20	(Margaret <i>et al.</i> 2014) [17].
Weeds	15-45	(Issue, 2019; Soltani <i>et al.</i> 2013) [18, 19].
Environmental factor	10-15	(Pagiola, 1995; Abate and Ampofo, 1996) [20, 21].



**Fig 2:** The Pyramid shows the factors due to country bean yield loss

### Insect Pests of Country Bean

In Bangladesh, Begum (1993) [22] observed many insects that attacked country bean field. Among them aphid was the most important and others were beetle, pod borer and mites. Khan *et al.* (2018) [23] observed five insect species were found, among them aphid (*Aphis craccivora* Koch), pod borer (*Maruca testulalis* G.) and epilachna beetle

(*Epilachna dodecastigma*) were recorded in both seasons. Shoot borer (*Acrobasis caryae*) and field cricket (*Brachytrypes portentosus*) were also found in winter and summer season, respectively in Sylhet. In Bangladesh (Table 2) the major insect and mite pests of country bean incidence of bean were aphid (*Aphis craccivora*), pod borers (*Maruca testulalis* G. and *Helicoverpa armigera*), leaf paster (*Hedylepta indicata* Fb), leaf beetle (*Sagra carbunculus* Hope, *S. femorata* Drury), leaf weevil (*Blosyrus oniscus*, *Alcides collaris* P.), hooded hopper (*Leptocentrus taurus* Fb.), lablab Bug (*Coptosoma cibrarium* F.), leaf eating caterpillar (*Plusia orichalcea* Fb.), leaf miner (*Cosmopterix* sp.) and red mite (*Tetranychus* sp.) (Karim 1995; Jayasinghe *et al.* 2015) [24, 25]. Das *et al.* (2014) [26] noted frequency of five key insects and mite infested of bean field in Bangladesh. These were aphid (*Aphis craccivora* Koch), flower bud and pod borer (*Maruca testulalis* G.), leaf miner (*Cosmopteryx* sp.), leaf past (*Hedylepta indicata* F.) and one mite (*Tetranychus* sp.). Khan *et al.* 2020 [27] observed that the aphid and pod borer significantly positive relationship with number of pods of country bean and temperature in Sylhet. Islam (1999) [28] recorded aphid (*Aphis medicaginis* Koch), leaf paster (*Hedylepta indicata* Fb), leaf miner (*Cosmopterix* sp.), pod borer (*Maruca testulalis* G.), bug (*Coptosoma cibrarium* F.), hooded hopper (*Leptocentrus Taurus* Fb.), mite (*T. etranychus* sp.), leaf beetle (*Sagra carbunculus* Hope, *S. femorata* Drury), leaf weevil (*Blosyrus oniscus*, *Alcides collaris* P.), leaf eating caterpillar (*Plusia orichalcea* Fb.) from country bean in on-station study. Alam (1969) [29] informed bean suffers from damages caused by nine different insect species and one species of mite. Four of these species such as aphid (*Aphis medicaginis* Koch), bean bug (*Coptosoma cibrarium* F.), leaf miner (*Cosmopterix* sp.) and mite (*Tetranychus* sp.) have been considered as major pests. Leaf miner had been recorded first to infest country bean leaves during 1963 in Dhaka farm. He also found green semilooper (*Plusia orichalcea*), hooded hopper (*Leptocentrus taurus* Fb.), shoot borers (*Sagra carbunculus* H. and *Sagra femorata* D.), shoot weevil (*Alcides collaris* P.), leaf weevil (*Blosyrus oniscus*), epilachna beetle (*Epilachna dodecastigma*) and shoot borer (*Acrobasis caryae*) as the minor pests. Khan *et al.* 2019 [30] observed that the infested pod and infested pod weight range from (1.91 to 10.37) % and (1.31 to 11.37) kg/plot during winter and summer season in Sylhet, Bangladesh.

In India, bean crop has been reported to be censured by more than 57 species of arthropods (Govindan, 1974; Ram *et al.* 2016) [31, 32]. About 30 species of insects have been reported damaging Indian bean. The major pests include aphids, sap-sucking bugs, pod borers, leaf miners and stem fly (Das *et al.* 2014) [26]. The major insect to common bean is stem maggot and aphid which cause the yield loss of about 37% to 100% and 37% Ochilo *et al.*, (2011) [14]. The galerucid beetle (*Madurasia obscurella* Jacoby) has been reported as an important insect of kharif pulses by Saxena (1976) [33]. In Africa, (Abate and Ampofo, 1996; Singh, 1983) [21, 34] reported that more than 30 insects attack country bean and the pest were leaf eating blue (*Oothecca bennigseni* Wse.), green beetles (*Hallirhotius africana* Jac.), bean stalk borer (*Chrytophlebia semilunana* Sal.), american boll worm (*Heliothis armigera* Hb.), striped weevil (*Alcidodes leucogrammus* Erichson), pollen beetle (*Mylabris* spp.), army worm (*Spodoptera* spp.), spiny brown

bugs (*Acanthomia* spp.) bean fly (*Melanagromyza phaseoli* Tryon), black bean aphid (*Aphis fabae*), pod borer (*Maruca testulalis* G.) and many species of thysanopterous, orthopterous and acaridaceous as the minor insects.

### Diseases of Country Bean

The bean diseases effect on healthy beans production Keikothaile and Spanoghe, (2011) [35]. Soil-borne diseases caused by fungi continue to be a threat in production of beans and so that smallholder farmers practice field hygiene, use certified seeds, carry out crop rotation and apply recommended pesticides (Monda *et al.* 2003) [36]. Many organisms involved bacteria, viruses and parasites (Rover, 1998) [37] to spared bean diseases in bean field agroecosystem.

More than 454 diseases in about 100 cultivated crops have

so far been noted in Bangladesh (Anonymous, 2008) [38]. From chorogram, 24 diseases with their incidence and severity were recorded in farmers' field (Hossain *et al.* 2010) [39]. Among them country bean is a very important crop in Bangladesh as cultivated in whole year. From the Table 2, the list of country bean diseases in Bangladesh as cercospora leaf spot of bean (*Cercospora cruenta*), foot and root rot bean (*Fusarium oxysporum*, *Rhizoctonia solani*, *Sclerotium rolfsii*), leaf rot (*Sclerotinia sclerotiorum*), wilt of bean (*Fusarium oxysporum*, *Pythium* sp., *Sclerotium* sp., *Rhizoctonia* sp.), powdery mildew (*Oidium* sp., *Erysiphe polygoni*), asian bean rust/rust bean (*Uromyces cicerina*, *U. phaseoli*), bean common mosaic-virus (Vet-Aphid), leaf blight (*Leptospaerulina trifoli*), blight disease of gram (*Ascochyta rabiei*) were observed in bean field.

**Table 2:** Review of literature on the major insects and diseases of country bean field

Insects	References
Aphid	Ochilo <i>et al.</i> , 2011; Khan <i>et al.</i> 2018; Jayasinghe <i>et al.</i> 2015; Das, 2014; Ram <i>et al.</i> 2016; Prabal, 2000; Bahar, 2007; Das <i>et al.</i> 2008; Jahan <i>et al.</i> , 2013 [14, 23, 25, 26, 32, 40, 41, 42, 43].
Pod borers	Khan <i>et al.</i> 2018; Jayasinghe <i>et al.</i> 2015; Ram <i>et al.</i> 2016; Huang, 2001; Huang, 2003 [23, 25, 32, 44, 45].
Leaf beetle	Karim 1995; Jayasinghe <i>et al.</i> 2015 [24, 25].
Epilakhna beetle	Khan <i>et al.</i> 2018; Karim 1995; Jayasinghe <i>et al.</i> 2015 [23, 24, 25].
Shoot borer	Khan <i>et al.</i> 2018; Karim 1995; Jayasinghe <i>et al.</i> 2015 [23, 24, 25].
Leaf weevil	Islam 1999; Yusuf, 1998; Ogunsina, 2011 [28, 46, 47].
leaf eating caterpillar	Jayasinghe <i>et al.</i> 2015; Ameh, and Okezie, 2005 [25, 48].
leaf miner	Jayasinghe <i>et al.</i> 2015; Das <i>et al.</i> 2014; Islam 1999; Ram <i>et al.</i> 2016 [25, 26, 28, 32].
red mite	Jayasinghe <i>et al.</i> 2015; Islam 1999; Alam 1969 [25, 28, 29].
Hooded hopper	Islam 1999; Uddin <i>et al.</i> 2013 [28, 49].
Bug	Jayasinghe <i>et al.</i> 2015; Islam 1999; Ram <i>et al.</i> 2016 [25, 28, 32].
Diseases	References
Cercospora leaf spot	Hawthorne <i>et al.</i> 2004; Egan <i>et al.</i> , 2006; Kimber <i>et al.</i> 2007; Richardson, 2008 [50, 51, 52, 53].
Anthracnose	Mulanya <i>et al.</i> , 2014 [54].
Foot and root rot	Allen 1995; Muthomi <i>et al.</i> 2007; Muthomi <i>et al.</i> 2014 [55, 56, 57].
Leaf rot	Genchev and Kiryakov 2002; Navarro and Nienhuis. 2008 [58, 59].
Angular leaf spot	Mulanya <i>et al.</i> , 2014 [54].
leaf blight	Shakir <i>et al.</i> 1999; Ward <i>et al.</i> 2008; Madgwick <i>et al.</i> 2011; Webb <i>et al.</i> 2011 [60, 61, 62, 63].
Wilt	Muthomi <i>et al.</i> 2007; Muthomi <i>et al.</i> 2014; Nguyen and Ranamukhaarachchi 2010 [56, 57, 64].
Powdery mildew	Da Silva <i>et al.</i> 2003 [65].
Rust	Mulanya <i>et al.</i> , 2014 [54].
Common mosaic-virus	Beaver, 2004; Beaver <i>et al.</i> 2005 [66, 67].
Root gall	Ameh and Okezie, 2005; Agu, 2008 [48, 68].

The list of some disease caused by pathogens in African country bean includes; *Oidium* spp., *Phoma* spp. and *Aecidium* spp. They have been identified as effective pathogens causing powdery mildew, leaf spot and stem rust respectively. Wilting leaf mosaic and root gall have equally been identified as diseases in African country bean (Ameh and Okezie, 2005; Agu, 2008) [48, 68]. Production of beans in Kenya is also severely forced by foliar diseases namely angular leaf spot, anthracnose and rust (Mulanya *et al.*, 2014) [54]. Anthracnose (*Colletotrichum lindemuthianum*), angular leaf spot (*Phaeoisariopsis griseola*), ascochyta blight (*Phoma exigua* and *Ascochyta phaseolorum*), powdery leaf spot (*Mycovellosiella phaseoli*), cercospora leaf spot (*Cercospora cruenta*), scab (*Sphaceloma* state of *Elsinoe phaseoli*), web blight (*Thanatephorus cucumeris* or *Rhizoctonia solani*), white mould (*Sclerotinia sclerotiorum*), bean common mosaic virus (BCMV) vector-aphid, bean yellow mosaic (BYMV) vector-aphid, common bacterial blight (*Xanthomonas campestris* pv. *Phaseoli*), charcoal rot (*Macrophomina phaseolina*), fusarium wilt or vascular wilt (*Fusarium oxysporum* f.sp.), halo blight (*Pseudomonas*

*syringae* pv. *phaseolicola* and pv. *Syringae*), root rots complex of root and stem rots (*Phythium* spp., *Rhizoctonia solani*, and *Fusarium solani*) and fungal alpha-amylases diseases found in African bean field Allen (1995) [55].

### Weeds of country bean

Weeds have been a persistent problem for farmers ever since beginning of agriculture because it causes economic losses by reductions in crop yields and quality, increase costs of crop production (Bhuler *et al.* 1998) [69]. Weed interference can result in large yield losses in as much as 58 to 99% (Dawit *et al.* 2011; Mukhtar, 2012) [70, 71] and 20-70% in bean and also interfere with harvest operations and may stain white bean, resulting in reduced market value (Abiye and Fasil, 2009; Urwin, 1999) [72, 73].

Some weeds such as smooth crabgrass (*Digitaria ischaemum*), large crabgrass (*Digitaria sanguinalis* L.), Bathua (*Chenopodium album* L.), wild radish (*Raphanus raphanistrum*), common groundsel (*Senecio vulgaris*), buttonweed (*Abutilon theophrasti* Medic.), bish katali (*Polygonum persicaria* L.), wild mustard (*Sinapis arvensis*

L.), and common chickweed (*Stellaria media*) were observed in bean field (Senseman, 2007; Omafra, 2011) [74-75]. The severe growing of weed impact the bean yield (Esmaeilzadeh and Aminpanah, 2015) [76].

### **Soil Nutrient of Country Bean**

Crop cannot exist without continuous supplies in adequate amounts of all essential nutrients. If even one nutrient is limiting or missing from the nutrient medium or diet of a plant in field, the plant will suffer and ultimately die. Summer country bean is anew introduced vegetable crop in our country. The bean yield is low (Khan *et al.* 2019) [30] of summer in Bangladesh as compared to the other nations of the world. The reasons of lower yield can be attributed to imbalanced use of fertilizer, growing more weed, not managed crop rotation, limited use of micro nutrients and so the organic matter decrease day by day from cultivated land. To recover the problem, the farmers mainly use N, P and K for crop production. In bean field boron and molybdenum fertilizer need to equilibrium influence three (N, P, K) macronutrients (Margaret *et al.* 2014; Raj, 1985) [17, 77] and help in protein synthesis and fixation of atmospheric nitrogen in the root of legume by nodule bacteria. Singh *et al.* (2008) [78] reported that application of molybdenum alone or combination with *S. rhizobium* significantly increased the grain of black gram in bean field.

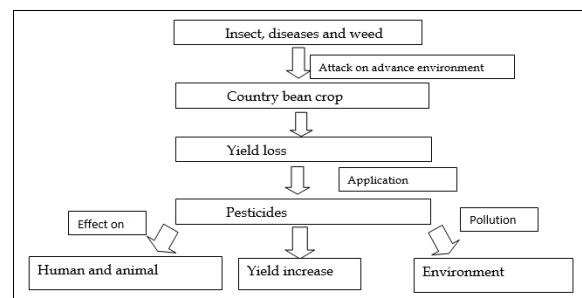
### **Management of Barriers for Successful Yield Production**

Bangladeshi farmers mainly apply insecticides and a little number of herbicides, fungicides, acaricides and rodenticides (Gain *et al.* 1998) [79] in the vegetable field in the form of granules, liquid and powder. It has been stated that 20 insecticides, 18 fungicides and 2 rodenticides, are being used in Bangladesh (Sattar, 1958) [80]. The key pesticides used by the farmers are Cypermethrin, Dichlorvos, Malathion, Carbofuran, Mancozeb and Diazinon depending upon the invading pests in Bangladesh (Ali, 2002) [81]. Besides, many pesticides used in Bangladesh are in the banned or restricted list under international agreements (Novib, 1993; Meisner, 2004; SUNS, 1998; SOS, 2004) [82, 83, 84, 85]. Insect managing is nowadays a worldwide ecological task mainly due to environmental pollution caused by widely used of synthetic chemical pesticides (Rattan, 2010) [86]. Pesticides are human-made and naturally occurring chemicals that control insects, diseases and weeds that damage the crop (Xiao *et al.* 2010; Clarke *et al.* 1997) [87, 88]. Synthetic pesticides have been used since 1945 in order to reduce crop harms due to plant pathogens. However, the use of pesticides has some detrimental penalties on environment, such as groundwater pollution, river eutrophication, soil erosion, excessive water use and the development of weeds and diseases resistant to chemical control (Lichtfouse *et al.* 2009) [89]. The harmful pesticides are melted in our water system and finally enter into the human ecosystem, fishes, many other animals and cause severe damage to their health (Khandakar, 1990) [90]. Furthermore, chemical pesticides as like as fertilizers contain heavy metals which were polluted the environment (Yusuf *et al.* 2003) [91]. Many chemical pesticides were used to control insects, diseases, weeds but it's advance hazardous for plant, animal and environment for that's why we were not including about chemical insecticide. Besides, botanical and bio-rational pesticides can be suggested as an environmentally safe, water soluble, less persistent, less risk

to apply in the presence of natural enemies and more toxic to pests compared to those of earlier first and second-generation pesticides in the management of agricultural insect, diseases and weeds of country bean field. Figure 3 indicate that solely used pesticides for controlling insects, diseases and weeds have a lot of detrimental effects on the environment and human health although these interventions increased the crop production. They are also easily biodegradable nature, systematic after application, capacity to alter the behavior of target insect, diseases, weeds and favorable for the evergreen revolution of the world.

**Azadirachtin:** Azadirachtin comprising neem (*Azadirachta indica*) seed extracts cause various effects in insects. The neem tree leaf, bark and seeds contain many substances with insecticidal properties. They act as antifeedants, growth regulators and sterilant. The effect upon insect development is most important from the viewpoint of practical insect control. Bioneem is a purely neem based water soluble mollifiable concentrate developed indigenously (Martineau, 1994; U.S. Environmental Protection Agency, 1993) [92, 93]. At early pod development stage, the neem oil was managed of larva of bean pod borer and aphid in 14.75 and 4.00 (No./plant) @ 4 ml/L of water at 7 days interval (Akter *et al.* 2013) [94].

**Imidacloprid:** Imidacloprid is seconhand to control sucking insects, termites, some soil insects, and fleas on pets. It has been used in crops vended in the United States since 1914 (Gervais *et al.* 2010) [95]. The imidacloprid insecticide was considered to control of aphids, wireworms, thrips and broad bean weevil (Kaniuczak and Matosz, 1998) [96]. The insecticide effectively managed the bean leaf roll virus, bean necrotic yellows virus and soybean dwarf virus (Makkouk and Kumari, 2001; Al-Jallad *et al.* 2007) [97, 98]. It was also effective on leaf miner (*Liriomyza huidobrensis*, Blanchard) and suppressed its parasitoid (*Diglyphus isaea*, Walker) (Chen *et al.* 2003) [99].



**Fig 3:** Flow chart about unsustainable management apprises pesticide

**Spinosad:** Spinosad is a biologically derived insecticide produced via fermentation culture of the actinomycete soil bacterium, *Saccharopolyspora spinosa*, a bacterial organism isolated from soil. The active elements in spinosad, 'spinosyn A and spinosyn D' are composite biological compounds made by soil microbes. Spinosad is a broad-spectrum pesticide but is only active if downed or contacted while in liquid form, so has little residual effect on most beneficial species (Nailah *et al.* 2009; Thompson *et al.* 2000) [100, 101]. In Australia, spinosad used as biocontrol agents, used against *Helicoverpa* spp. while conserving beneficial insects (Thompson *et al.* 2000) [101].

**Chlorfenapyr:** Chlorfenapyr is a pesticide and specifically a pro-insecticide (meaning it is metabolized into an active insecticide after entering the host) derived from a class of microbially produced compounds known as halogenated pyrroles (Oliver *et al.* 2010)<sup>[102]</sup>.

**Sex pheromone:** Sex pheromones is composed of linear fatty acid-derived compounds, 12–18 carbons in chain length major group (type I), with an oxygenated functional group and one to three double bonds. A second major class (type 2) of sex pheromones is built on hydrocarbons through a polyene and/or epoxide practical cluster. This class of pheromones is typically start in four large moth families, the Geometridae, Noctuidae, Arctiidae, and Lymantridae (Byer, 2006)<sup>[103]</sup>. The polyene type is biosynthesized from food derived linoleic or linolenic acids and characterized by 17–23 carbon chains with 1–4 double bonds, and 0–2 epoxides (Millar, 2000)<sup>[104]</sup>. The location of the males towards the females is supposed to be mediated by a female (Pizano, 1991)<sup>[105]</sup>, since traps covering virgin females have wedged up to 192 males (Roccia, 1977)<sup>[106]</sup> however decisive proof has been absent.

**Microbial insecticides:** Microbial insecticides containing *Bacillus thuriengiensis* gram-positive pore-forming soil bacterium cause of the acute and often lethal disease anthrax. It is used as insecticides as environment friendly as an alternative conventional chemical pesticide for almost 60 years but in our country, it's a new concern use as pesticides. It is a biological warfare agent. Virulent forms of *B. thuriengiensis* harbor two plasmids, pXO1 of 181kb and pXO2 of 93.5 kb which recently have been completely sequenced (Okinaka *et al.*, 1999; Thorne, 1993)<sup>[107, 108]</sup>. *Bacillus thuringiensis* ssp. is used in beans to manage lepidopteran larvae, including *Helicoverpa* spp., diamondback moth and *Chrysodeixis* loopers (Anonymous 2008)<sup>[38]</sup>.

**Integrated pest management:** The concept of Integrated pest management (IPM) is becoming more and more popular among farmers, researchers, and policy makers in Bangladesh. In IPM, a range of methods are used for pest, diseases and weed control. IPM seeks to lessen trust on pesticides by highlighting on the contribution of other control methods, including biological control, resistance plant breeding, and cultural techniques. Furthermore, IPM is as “magic bullets” places less emphasis on expensive pesticides and more on renewable technologies available to the resource-poor farmer, such as biological control and host plant resistance, it is more possible for these farmers to share the benefits of this approach but many different things to many different people (Waage, 1998)<sup>[109]</sup>. The IPM way it is actually conducted in the majority of crop systems today still places emphasis on single technologies such as the use of pesticides, biocontrol, or host plant resistance and rarely considers the interactions among them (Thomas and Waage, 1996)<sup>[110]</sup>.

**Biological control of weeds:** Generally, in bean field weeds are manage in winter bean. In summer, there is growing loss of weed and it's a laborious work to control weed. Harris (1988)<sup>[111]</sup> defined biocontrol of weeds as the use of undomesticated organisms that feed on the weed for the purpose of reducing its density, vigor, or reproduction. Quimby, 1990<sup>[112]</sup> said that planned use of living organisms

to reduce the vigor, reproductive capacity, density, or effect of weeds. The agricultural sector can develop various methods like as introduction of exotic biocontrol agents; increase of native biocontrol agents (herbicides); grazing systems and positive conditioning that enable livestock of various classes to eat the weeds. Grazing is desirable forage in ways that help keep weeds in check; aversion conditioning of livestock to avoid palatable poisonous weeds; and the use of superior, fast-growing forages that can successfully compete with troublesome weeds.

### Safety Food

Bangladesh has made substantial evolution towards achieving its goal of food grain self-sufficiency. This achievement has been based on a considerable intensification of agriculture. Agricultural farming activities are mainly occurring of rural in Bangladesh. Most of the people here depend on agriculture. Agriculture sector contributes about 14.49% to GDP (BER, 2018)<sup>[113]</sup>. The agriculture sector comprises crops (10.11%) of the GDP was derived from crops (BER, 2018)<sup>[113]</sup>. Ensuring food security for the enormous population of Bangladesh is directly related with the agricultural development in the country. Bangladesh is predominantly an agrarian country and having an area of 1, 47,570 km<sup>2</sup> is inhabited by 160.295 million people 22% of whom live below the national poverty line of US \$2 per day and the population density per km<sup>2</sup> is 1078 (BER, 2018)<sup>[113]</sup>. In addition, child malnutrition charges are presently at 48%, in complaint that is tied to the low social rank of women in Bangladeshi society. To alleviate poverty and malnutrition in our country it is necessary to enlarge production and feasting of nutritious and health-promoting vegetables.

### Market Price of Country Bean

The marketable price is varying from time to time, place to place, market to market and season to season (Arshad and Zainalabidin, 1994)<sup>[114]</sup>. Summer country bean price is more than the winter bean. The country bean price range 30 to 100 tk/kg in both season survey from local two market in East-Northern part, Bangladesh. The BCR of country bean yield was 2.003 where was the gross returns 483500/- tk in Bangladesh in 2014 (Chowdhuri *et al.*, 2014)<sup>[115]</sup>.

### Conclusion

The significance of increased country bean production faces abiotic and biotic problem in country bean agroecosystem. In recent years, chemical insecticides applied in bean field which were hazard for the animal, plant and environment in recent years, chemical insecticides applied in bean field which were hazard for the animal, plant and environment. Accordingly, bio-rational and botanical insecticides application have increased to consider the environment issue.

**Author Contributions:** A.U.K. and M.A.R.C. were planned, structured, wrote, and revised the manuscript thoroughly. M.S.A.T., M.S.H., S.A., T.A., and M.E. contributed to the help in writing and revision of the manuscript.

### References

1. Sibiko KW, Ayuya OI, Gido EO, Mwangi JK. An analysis of economic efficiency in bean production :

- evidence from eastern Uganda. Journal of Economics and Sustainable Development. 2013; 4(13):1-10.
2. Chowdhury AR, Ali M, Quadir MNA, Talukder MH. Floral biology of country bean (*Lablab purpureas* L. sweet). Thai Journal of Agricultural Science. 1989; 22:56-67.
  3. Singh BP, Singh B. Response of French bean to phosphorus and boron in cid Alfisols in Meghalaya. Journal of the Indian Society of Soil Science. 2019; 38(4):769-771.
  4. Aditya DK. Vegetables Production and development in Bangladesh. Consultancy report, AVRDC-USAID (ARPTI) project, 22 November, 1992-31, May 1993. Horticulture Research Center, BARI, Joydebpur, 1993, 3-24.
  5. Karla VK. Integrated control of the pest complex of mustard. PhD Thesis, Department of Entomology, Haryana Agricultural University, India, 2009, 17-19.
  6. Sultana N. Genetic variation of morphology and molecular markers and its application to breeding in *Lablab* bean. PhD Thesis, Kyushu University, Fukuoka, Japan, 2001, 143.
  7. Anonymous. Krishi Diary (in Bengali), Agriculture Information Service, Khamarbari, Farmgate, Ministry of Agriculture, Dhaka, Bangladesh, 2013, 73.
  8. Rehana MJ. Effects of phosphorous and mulching on the growth and yield of French bean. MS thesis, Department of Horticulture, Bangladesh Agricultural University, Mymensingh-2204, 2006, 1-92.
  9. Wortman SC, Kirkby AR, Eledu AC, Allen JD (Eds.). Atlas of *Phaseolus vulgaris* L. production in Africa. Cali, Colombia: International Centre for Tropical Agriculture, CIAT, 2004, 131.
  10. Ye XY, Wang HX, Ng TB. Dolichin, a new chitinase-like antifungal protein isolated from field beans (*Dolichos lablab*). International Journal of Applied Biochemistry and Biotechnology, Orlando, USA. Academic Press. 2000; 269(1):155-159.
  11. Buruchara RA, Scheidegger UC. Development and Delivery of bean varieties in africa: The Pan-Africa bean research Alliance (PABRA) model. African Crop Science Journal. 2011; 19(4):227-245.
  12. Widers IE. The beans for health alliance: a public-private sector partnership to support research on the nutritional and health attributes of beans. Annual Reproduction of Bean Improvement Coop. 2006; 49(1):3-5.
  13. Singh SR, Allen DT. Pests, diseases resistance and protection in cowpea. In: Advanced Legume Science Ed. Summerfield, England, 1980, 419-443.
  14. Ochilo WN, Nyamasyo GH. Pest Status of Bean Stem Maggot (*Ophiomyia* spp.) and Black Bean Aphid (*Aphis fabae*) in Taita District, Kenya. Situación de las plagas Del frijol: Gusano del Tallo. Tropical and Subtropical Agroecosystems. 2011; 13:91-97.
  15. Uddin M, Rahman M, Alam M, Hossain M, Hoque M. Effect of farmers' practices for the management of insect pests of yard long bean (*Vigna unguiculata*). Bangladesh Journal of Agricultural Research. 2014; 39(1):173-184.
  16. Singh SP, Schwartz HF. Breeding common bean for resistance to diseases: A review. Crop Science. 2010; 50(6):2199-2223.
  17. Margaret N, Tenywa JS, Otabbong E, Mubiru DN, Ali T. Development of Common Bean (*Phaseolus Vulgaris* L.) Production under Low Soil Phosphorus and Drought in Sub-Saharan Africa: A Review. Journal of Sustainable Development. 2014; 7(5):128-139.
  18. Issue S. The spatial epidemiology of jackfruit pest and diseases: a review. International Journal of Built Environmental and Sustainability. 2019; 6(1-2):169-175.
  19. Soltani N, Nurse RE, Shropshire C, Sikkema PH. Weed Control in White Bean with Pendimethalin Applied Preplant Followed by Postemergence Broadleaved Herbicides, 2013, 24-30.
  20. Pagiola S. Environmental and Natural Resource Degradation in Intensive Agriculture in Dhaka, Bangladesh. 1995; 15(2):10.
  21. Abate T, Ampofo JKO. Insect pests of beans in Africa: their ecology and management. Annual Review of Entomology. 1996; 41:45-73.
  22. Begum RA. Techniques of growing legume vegetable. In: Intensive vegetable growing and its utilization. A compilation of lecture materials of training course held in BARI, Joydebpur, Gazipur, Bangladesh. 22-25 November 1993, 94-115.
  23. Khan AU, Choudhury MAR, Islam MS, Maleque MA. Abundance and Fluctuation Patterns of Insect Pests in Country Bean, Journal of Sylhet Agricultural University. 2018; 5(2):167-172.
  24. Karim MA. Management of insect pest of vegetables. In: Chadha, M.L., Ahmad, K.U., Shanmugasundaram S., and Quasem, A. (eds.) Vegetable Crops Agribusiness. Proceedings of a workshop held at BARC, Dhaka, Bangladesh 2-4 May., AVRDC, BARC and BARI, 1995.
  25. Jayasinghe RC, Premachandra WTSD, Neilson R. A study on *Maruca vitrata* infestation of Yard-long beans. Heliyon, 2015, 1(1). <https://doi.org/10.1016/j.heliyon.2015.e00014>.
  26. Das R, Thapa U, Debnath S, Lyngdoh YA, Mallick D. Evaluation of French bean (*Phaseolus vulgaris* L.) genotypes for seed production. Journal of Applied and Natural Science. 2014; 6(2):594-598.
  27. Khan AU, Choudhury MAR, Dash CK, Khan UHS, Ehsanullah M. Insect Pests of Country Bean and Their Relationships with Temperature. Bangladesh Journal of Ecology. 2020; 2(1):43-46.
  28. Islam MA. Integrated Pest (Insects) Management of Vegetables. Consultancy Report, 18 November 1998 - 17 May 1999. AVRDC - USAID Bangladesh Project, Horticulture Research Center, BARI, Gazipur- 1701. Journal of American Science. 1999; 4:76-79.
  29. Alam MZ. Insect pests of vegetables and their control in East Pakistan. Publish by The Agriculture Information Service. Department of Agriculture; 3, R.K. Mission Road, Dhaka-3, East Pakistan, 1969, 146-177.
  30. Khan AU, Choudhury MAR, Ferdous J, Islam MS, Rahaman MS. Varietal Performance of Selective Country Beans Against Insect Pest in Bean Agroecosystem. Bangladesh Journal of Entomology. 2019; 29(1):27-37.
  31. Govindan R. Insects of the field bean (*Lablab niger* var. *lingosus medikus*) with special reference to the biology and ecology of the pod borer, *Adisura atkinsoni* Moore (Lepidoptera: Noctuidae). M.Sc. (Agri.) thesis. U.A.S.,

- Bangalore, 1974, P.92.
32. Ram H, Rashid A, Zhang W, Duarte A, Phattarakul N, Simunji S. Biofortification of wheat, rice and common bean by applying foliar zinc fertilizer along with pesticides in seven countries. *Plant and Soil*. 2016; 403(1-2):389-401.
  33. Saxena HP. Insects of kharif pulses. In: Bulletin on pest management on plant protection training, Farm adv. unit, Directorate of Extension, Ministry of Agriculture and Irrigation, New Delhi, 1976, 263-264.
  34. Singh JP. Crop protection in the tropics. Vikas publishing house PVT. LTD. New Delhi 110002, 1983, 192-202.
  35. Keikotlhaile BM, Spanoghe P. Pesticide residues in fruits and vegetables, pesticides-formulations, effects, fate. In Tech, Rijeka, Croatia, 2011, 243-252.
  36. Monda EO, Munene S, Ndegwa A. Snap bean production constraints in Kenya. *African Crop Science*. 2003; 6:683-687.
  37. Rover De C. Microbial safety evaluations and recommendations on fresh produce. *Food Control*. 1998; 9(6):321-347.
  38. Anonymous. Queensland Department of Primary Industries, Brisbane, Queensland, Australia. Information of pest PC. 2008; 2:11.
  39. Hossain MT, Hossain SM, Bakr MA, Matiar AKM, Uddin SN. Survey on major diseases of vegetable and fruit crops in Chittagong region. *Bangladesh Journal of Agricultural Research*. 2010; 35(3):423-429.
  40. Prabal S, Debanand D, Latu S. Evaluation of botanicals and fish oil formulation against bean aphid, *Aphis craccivora* Koch. *Journal of the Agricultural Science Society of North East India*. 2000; 13(1):79-80.
  41. Bahar MH, Islam A, Mannan A, Uddin J. Effectiveness of Some Botanical Extracts on Bean Aphids Attacking Yard-Long Beans. *Journal of Entomology*. 2007; 4:136-142.
  42. Das BC, Sarker PK, Rahman MM. Aphidicidal Activity of Some Indigenous Plant Extracts against Bean Aphid *Aphis Craccivora* Koch (Homoptera: Aphididae). *Journal of Pest Science*. 2008; 81(3):153-59.
  43. Jahan R, Uddin MM, Rahman MM, Haque MA. Varietal Preference and Management of Bean Aphid, *Aphis Craccivora* (Koch), 2013, 40-46.
  44. Huang CC, Peng WK. Emergence, mating and oviposition of the bean pod borer, *Maruca vitrata* (F.) (Lepidoptera: Pyralidae). *Formosan Entomology*. 2001; 21:37-45.
  45. Huang CC, Peng WK, Talekar NS. Characteristics of infestation by the bean pod borer, *Maruca vitrata* (Lepidoptera: Pyralidae) on *Sesbania cannabina*. *Formosan Entomology*. 2003; 23:1-11.
  46. Yusuf SR, Ahmed BI, Chaudhary JP, Yusuf AU. Laboratory evaluation of some plant products for the control of maize weevil *S. zeamais* (mots) in stored maize. *ESN Occasional Publication*. 1998; 31:203-213.
  47. Ogunsina OO, Oladimeji MO, Lajide L. Insecticidal action of hexane extracts of three plants against bean weevil, *Callosobruchus maculatus* and maize weevil, *Sitophilus zeamais* motsch. *Journal of Ecology and the Natural Environment*. 2011; 3(1):23-28.
  48. Ameh GI, Okezie CEA. Pests and diseases of African yam bean, *Sphenostylis stenocarpa* (Hoechst. ex A. Rich) harms. *Biological Research*. 2005; 3:14-20.
  49. Uddin MS, Rahman MM, Alam M, Awal ZA, Mazed MA. Insect Pests of Yard Long Bean (*Vignaunguiculata* subsp. *Sesquipedalis* L.) in Major Growing Areas of Bangladesh. *Agriculturists*. 2013; 1(2):66-73.
  50. Hawthorne WA, Bretag T, Raynes M, Davidson JA, Kimber RBE, Nikandrow A et al. 2004. [http://www.pulseaus.com.au/crops/faba\\_beans/](http://www.pulseaus.com.au/crops/faba_beans/). Accessed 23th March, 2020.
  51. Egan J, McMurray L, Paull J, Davidson J, Crouch J. Reducing management inputs and maximizing seed quality in faba beans through improved varieties. *Australian Society of Agronomy*, 2006, 35-37.
  52. Kimber RBE, Davidson JA, Paull JG, Scott ES. Epidemiological studies of Cercospora leaf spot in faba beans. In: Proceedings of the 16th Australasian Plant Pathology Society Conference, APPS, Adelaide, Australia, 2007, 91.
  53. Richardson H. 2008. [http://www.dpi.vic.gov.au/dpi/nreninf.nsf/v/938983710829513CA25746B000FAB8B/\\$file/Chocolate\\_Spot\\_of\\_Faba\\_Bean.pdf](http://www.dpi.vic.gov.au/dpi/nreninf.nsf/v/938983710829513CA25746B000FAB8B/$file/Chocolate_Spot_of_Faba_Bean.pdf). Accessed 23th March, 2020.
  54. Mulanya MM, Kimani PM, Narla RD. Selection for multiple disease resistance in bush snap bean lines developed in Kenya. *Proceedings of Fourth Reform Biennial Conference*, Maputo, Mozambique, 2014.
  55. Allen DJ. An annotated list of diseases, pathogens and associated fungi of the common bean (*Phaseolus vulgaris*) in eastern and southern Africa. CAB International and CIAT, Wallingford, UK. *Phytopathological*, 1995, 34.
  56. Muthomi JW, Otieno PE, Chemining'wa GN, Nderitu JH, Wagacha JM. Effect of legume root rot pathogens and fungicide seed treatment on nodulation and biomass accumulation. *Journal of Biological Sciences*. 2007; 7:1163-1170.
  57. Muthomi JW, Mugambi IK, Ojiem J, Chemining'wa GN, Nderitu JH. Effect of incorporating lablab biomass in soils on root rot disease complex and yield of beans intercropped with maize. *International Journal of Agriculture Science*. 2014; 4(12):515-524.
  58. Genchev D, Kiryakov I. Inheritance of resistance to white mold disease (*Sclerotinia sclerotiorum* (Lib.) de Bary) in the breeding line A 195 of common bean (*Phaseolus vulgaris* L.). *Bulgarian Journal of Agricultural Science*. 2002; 8:181-187.
  59. Navarro FM, Sass Nienhuis J. Identification and confirmation of quantitative trait Loci for root rot resistance in snap bean. *Crop Science*. 2008; 48:962-972.
  60. Shakir AS, Iqbal MZ, Sahi ST. First report on Association of Some Fungal Organisms with Dodder (*Cuscuta*) Blight in Pakistan. *Pakistan Journal of Biological Sciences*. 1999; 2(3):991-992.
  61. Ward TJ, Clear RM, Rooney AP. An adaptive evolutionary shift in Fusarium head blight pathogen populations is driving the rapid spread of more toxigenic Fusarium graminearum in North America. *Fungal Genetic Biology*. 2008; 45:473-484.
  62. Madgwick JW, West JS, White RP. Impacts of climate change on wheat anthesis and Fusarium ear blight in the UK. *Journal of Plant Pathology*. 2011; 129:117-131.
  63. Webb KM, Ona I, Bai J, Garrett KA, Mew T, Cruz

- CMV *et al.* A benefit of high temperature: increased effectiveness of a rice bacterial blight disease resistance gene. *New Phytol.* 2011; 185:568-576.
64. Nguyen MT, Ranamukhaarachchi SL. Soil-borne antagonists for biological control of bacterial wilt disease caused by *Ralstonia solanacearum* in tomato and pepper. *Journal of Plant Pathology.* 2010; 92(2):395-406.
  65. Da Silva GF, dos Santos JB, Ramalho MAP. Identification of SSR and RAPD markers linked to a resistance allele for angular leaf spot in the common bean (*Phaseolus vulgaris*) line ESAL 550. *Genetics and Molecular Biology.* 2003; 26:459-463.
  66. Beaver JS. Inheritance of normal pod development in bean golden yellow mosaic resistant common bean. *Journal of the American Society for Horticultural Science.* 2004; 129:549-552.
  67. Beaver JS, Muñoz-Perea CG, Osorno JM, Ferwerda FH, Miklas PN. Registration of bean golden yellow mosaic virus resistant dry bean germplasm lines. PR9771-3-2, PR0247-49 and PR0157-4-1. *Crop Science* 2005; 45: 2126-2127.
  68. Agu CM. Effects of organic manure types on root-gall nematodes diseases an African yam bean yield. *Agricultural Journal.* 2008; 3(1):14-16.
  69. Bhuler DD, Netzer DIA, Riemschneider DE, Hartzler RG. Weed management in short rotation poplar and herbaceous perennial crops grown for biofuel production. *Biomass and Bioenergy.* 1998; 14(4):385-394.
  70. Dawit D, Sharma JJ, Lisanework N. Effect of Pendimethalin and Smetolachlor Application Rates on Weed Dynamics and Yield of Common bean (*Phaseolus vulgaris* L.) at Areka, Ethiopia. *Ethiopian Journal of Weed Management.* 2011; 4:37-53.
  71. Mukhtar AM. Critical period of weed interference in irrigated common bean (*Phaseolus vulgaris* L.) in Dongola area. *Journal of Science and Technology.* 2012; 12(3):1-6.
  72. Abiye G, Fasil R. Effect of Crop and Weed Management Methods on Weed Control, Productivity and Quality of Haricot Bean (*Phaseolus vulgaris* L.). *Ethiopian Journal of Weed Management.* 2009; 3:1-11.
  73. Urwin CP, Wilson RG, Mortensen DA. Responses of dry edible bean (*Phaseolus vulgaris*) cultivars to four herbicides. *Weed Technology.* 1999; 10:512-518.
  74. Senseman SA. Herbicide Handbook, (9th ed). Champaign, IL: Weed Science Society of America, 2007, 458.
  75. Omafra. Ontario Ministry of Agriculture, Food and Rural Affairs. *Guide to weed control.* Publ. Toronto, ON, Canada, Omafra. 2011; 75:348.
  76. Esmaeilzadeh S, Aminpanah H. Efeito da Época de plantio e do arranjo espacial em feijoeiro comum (*phaseolus vulgaris*) com e sem infestação de plantas daninhas. *Planta Daninha.* 2015; 33(3):425-432.
  77. Raj S. Groundnut. An introduction to physiology of field crops. Oxford and IBH publishing Co., New Delhi, 1985, 94-97.
  78. Singh RP, Bisen JS, Yadav PK, Singh SN, Singh RK, Singh J. Integrated use of sulphur and molybdenum on growth, yield and quality of blackgram (*Vigna mungo* L.). *Legume Research.* 2008; 31(3):214-217.
  79. Gain P. Pesticide Doesn't Guarantee Increased Crop Yield in Gain P. (Eds). *Bangladesh Environment: Facing the 21st Century*, Society for Environment and Human Development (SEHD), Dhaka, 1998.
  80. Sattar MA. Use of pesticides in Bangladesh and protection of the environment. Proceeding of the seminar on protecting the environment from degradation. SAARC, Dhaka, 1985, 58-63.
  81. Ali SMK, Rahman MM Hossain AMMM. Pesticide use and male fertility in Bangladesh. In Ahmed M.F. (Eds 2019). *Bangladesh Environment* 2002, (Bangladesh Paribesh Andolon, BAPA), 2002, 1.
  82. Novib. Pesticides Misuse in Bangladesh. The Pesticides Trust, London: UK, December, 1993.
  83. Meisner C. Report of pesticide hotspots in Bangladesh, Report to the Canadian International Development Agency, Mimeo, World Bank: Washington DC, 2004, 1(1): Available at: <http://www.worldbank/nipr>.
  84. SUNS. Pesticide over use takes serious turn in Bangladesh, Jan. 23, 1998. (Dhaka, Jan. 23 IPS/Tabibul Islam).
  85. SOS-Arsenic.net. 2004. Agrochemicals, Imported Pollutants in Bangladesh. <http://www.sos-arsenic.net/index.html>. Accessed 23th March, 2020, 1-18.
  86. Rattan RS. Mechanism of action of insecticidal secondary metabolites of plant origin. *Crop Protection* 2010; 29:913-920.
  87. Xiao YM, Wang JA, Wang MA, Liu JP, Yuan HZ, Qin ZH. Study on the Inclusion Complexes of Flumorph and Dimethomorph with  $\beta$ -Cyclodextrin to improve fungicide formulation. *Journal of the Chemical Society of Pakistan.* 2010; 32:363-369.
  88. Clarke EE, Levy LS, Spurgeon A, Calvert IA. The problem associated with pesticide use by irrigation workers in Ghana. *Occupational Medicine.* 1997; 47:301-308.
  89. Lichtfouse E, Navarrete M, Debaeke P, Souche're V, Alberola C, Me'nassieu J. Agronomy for sustainable agriculture. A review. *Agronomy for Sustainable Development.* 2009; 29:1-6.
  90. Khandakar K. Population, Agriculture and Environmental Degradation. An article published in the daily: The Bangladesh Observer, 1990.
  91. Yusuf AA, Arowolo TA, Bamgbose O. Copper and Nickel levels in vegetables from industrial and residential areas of Lagos City, Nigeria. *Food and Chemical Toxicology.* 2003; 41:375-378.
  92. Martineau J. Agri Dyne Technologies, Inc. January 26, MSDS for Azatin-EC Biological Insecticide, 1994. <http://npic.orst.edu/factsheets/archive/imidacloprid.html>
  93. US Environmental Protection Agency. Azadirachtin, Tolerance Exemption. *Federal Register,* 1993, 58(30).
  94. Akter R, Rahman MM, Ali MR. Evaluation of Different Management Practices in Controlling Major Insect Pests of Country. MS Thesis, Department of Entomology, Sher-E-Bangla Agricultural University, Dhaka, 2013, 1-96.
  95. Gervais JA, Luukinen B, Buhl K, Stone D. Imidacloprid General Fact Sheet; National Pesticide Information Center, Oregon State University Extension Services 2010. Retrieved, 2012.
  96. Kaniuczak Z, Matosz I. The effect of insecticidal seed dressings upon the broad bean weevil (*Bruchus rufimanus* Boh.) in the cultivation of the field bean.

- Journal of Plant Protection Research.* 1998; 38:84-88.
97. Makkouk KM, Kumari SG. Reduction of incidence of three persistently transmitted aphid-borne viruses affecting legume crops by seed-treatment with the insecticide imidacloprid (Gaucho1). *Crop Protection.* 2001; 20:433-437.
  98. Al-Jallad R, Kumari SG, Ismail ID. Integrated management of aphid-transmitted faba bean viruses in the coastal area of Syria. *Arab Journal of Plant Protection.* 2007; 25:175-180.
  99. Chen A, Chen Z, Luo K, Miao S. Effects of some insecticides on field population fluctuation and parasitism of the leaf miner parasitoid. *Yunnan Agricultural University.* 2003; 18:249-252.
  100. Nailah A, Shaffner J, Richey K, Crouse GD. Novel mode of action of Spinosad: Receptor binding studies demonstrating lack of interaction with known insecticidal target sites. *Pesticide Biochemistry and Physiology.* 2009; 95:1-5.
  101. Thompson GD, Dutton R, Sparks TC. Spinosad-a case study: an example from natural products discovery program. *Pest Management Science.* 2000; 56:696-702.
  102. Oliver SVM, Kaiser L, Wood OR, Coetzee CR, Rowland M, Brooke BD. Evaluation of the pyrrole insecticide chlorfenapyr, its Toxicity and mode of action. *Tropical Medicine and International Health* 2010; 15:127-131.
  103. Byer JA. Pheromone component patterns of moth evolution revealed by computer analysis of the Pherolist. *Journal of Animal Ecology.* 2006; 75:399-407.
  104. Millar JG. Polyene hydrocarbons and epoxides: a second major class of lepidopteran sex attractant pheromones. *Annual Review of Entomology.* 2000; 45:575-604.
  105. Pizano MA. Potencial de controle de *Migdolus fryanus* (Westwood, 1963) (Col.: Ceram- bycidae) Através de armadilha de feromônio sexual. *International Congress of Entomology.* XIII, Recife. Resumos, 1991, 331.
  106. Roccia AO. Estudos sobre a bioecologiae controle de *Migdolus* spp. (Coleoptem, Cerambycidae). *Annual Review of Entomology.* 1977; 27:369-384.
  107. Okinaka R, Cloud KO, Hampton A, Hoffmaster K, Hill P, Keim T *et al.* Sequence, assembly and analysis of pX01 and pX02. *Journal of Applied Microbiology.* 1999; 87:261-262.
  108. Thorne CB. *Bacillus anthracis*. In Sonenschein, A.L., Hoch JA, Losick R. (ed.), *Bacillus subtilis and other gram-positive bacteria*. American Society for Microbiology, Washington, DC, 1993, 113-124.
  109. Waage JK. The Future Development of IPM. *Entomologia Sinica.* 1998; 5(3):257-271.
  110. Thomas MB, Waage JK. Integration of Biological Control and Host Plant Resistance Breeding: A Scientific and Literature Review, Technical Centre for Agricultural and Rural Cooperation of the European Union, Wageningen, The Netherlands, 1996.
  111. Harris P. Environmental impact of weed control insects. *Occasional Papers of the California Academy of Sciences. Biological Science.* 1988; 38:542-548.
  112. Quimby PC, Christy AL, Child RD, Soper RS. *In: Proceedings of National Grazing Lands Weed Management Conference* (E Lehnert, Ed.), 1990, 81-86.
  113. BER. Economic Advisory Section, Bangladesh Economic Review, Department of Finance, Ministry of Finance, Bangladesh, 2018.
  114. Arshad FA, Zainalabidin M. Price discovery through crude palm oil futures market: An economic evaluation. *Proceedings of the 3rd Annual Congress on Capitalisingthe Potentials of Globalisation-Strategies and Dynamics of Business, (CPGSDB'94), IMDA, Malaysia,* 1994, 73-92.
  115. Chowdhuri NY, Haque S, Shammi SA, Jannat A, Sannyashi PR. Profitability analysis of winter vegetables production in a selected area of Narshingdi district in Bangladesh. *Progressive Agriculture.* 2014; 25:47-53.